

Annual Project Performance Report

1. State: California

Grant number: F-123-R-1

Grant name: Inland and Anadromous Sport Fish Management and Research

Project number and name: #71 – Bay-Delta Sport Fish Resource Assessment – Striped Bass

2. Report Period: July 1, 2009 through June 30, 2010

3. Location of work: Congressional District #'s 1 – 16 and #18. Marin, Contra Costa, San Francisco, San Mateo, Santa Clara, Alameda, Solano, San Joaquin, Stanislaus, Sacramento, Yolo, Sutter, Colusa, Glenn, and Butte Counties.

4. Objectives:

Job #1: Summer Abundance of Juvenile Striped Bass — Index the abundance of age-0 (38.1 mm) striped bass during the summer through a tow-net survey (Tow Net Survey; TNS) and evaluate environmental factors causing annual variations in those indices.

Job #2: Fall Abundance of Juvenile Striped Bass — Index the abundance of age-0 striped bass during fall (FMWT) through mid-water trawl surveys and evaluate environmental factors causing annual variations in those indices.

Job #3: Age Composition and Population Size of Striped Bass in California's Sacramento Estuary — Estimate the age composition, recruitment, and abundance of legal-sized striped bass using mark-recapture methods and information on catch from Commercial Passenger Fishing Boats.

Job #4: Exploitation and Survival Rates of Striped Bass in California's Sacramento-San Joaquin Estuary — Estimate annual exploitation and survival rates of legal-sized striped bass.

5. If the work in this grant was part of a larger undertaking with other components and funding, present a brief overview of the larger activity and the role of this project: This work is performed under the auspices of the Interagency Ecological Program for the San Francisco Estuary (IEP) as well as DFG. The IEP provides information on the factors that affect ecological resources in the Sacramento - San Joaquin Estuary that allows for more efficient management of the estuary.

The goals of IEP are: (1) To provide for the collection and analysis of data needed to

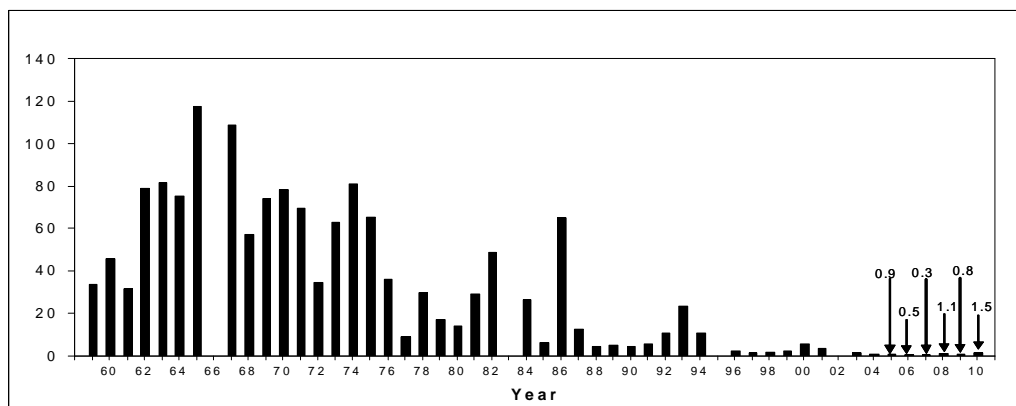
understand factors in the Sacramento-San Joaquin estuary controlling the distribution and abundance of selected fish and wildlife resources and make the data readily available to other agencies and the public; (2) To comply with permit terms requiring ecological monitoring in the estuary; (3) To identify impacts of human activities on the fish and wildlife resources; (4) To interpret information produced by the program and from other sources and, to the extent possible, recommend measures to avoid and/or offset adverse impacts of water project operation and other human activities on these resources; (5) To seek consensus for such recommendations, but to report differing recommendations when consensus is not achieved and; (6) To provide an organizational structure and program resources to assist in planning, coordination, and integration of estuarine studies by other units of cooperating agencies, other agencies, and academia.

Information from these Jobs is complementary and necessary to manage striped bass in the San Francisco Estuary. The adult striped bass abundance estimate allows estimation of egg production and year-class strength at recruitment to the fishery, the TNS and FMWT data are used to index summer survival for age-0 striped bass, and the FMWT index enables investigation into the effects of natural (e.g., freshwater flow) and man-made (e.g., water diversion) factors on population trends of age-0 striped bass.

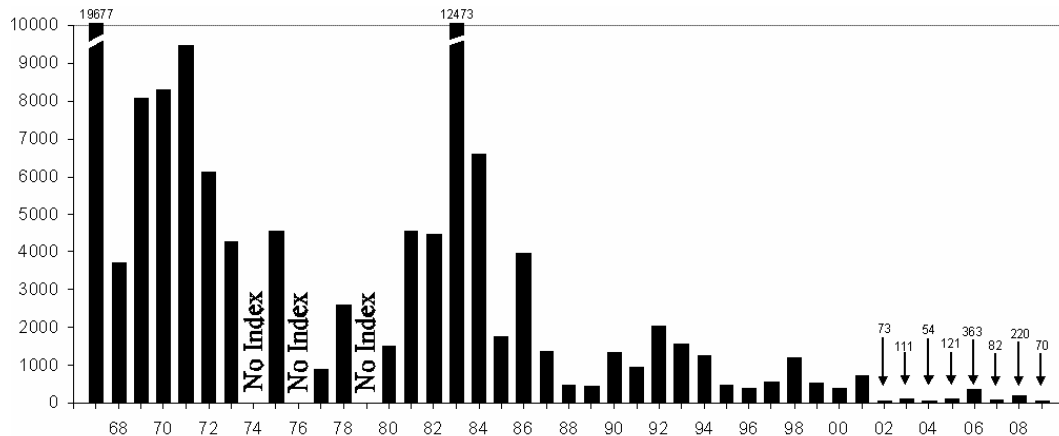
This Project is critical in a multi-agency effort to investigate recent declines of multiple pelagic fishes and zooplankton in the Sacramento-San Joaquin Delta. This study shows record low abundance indices for age-0 striped bass for much of this century, as well as record-low abundances for striped bass prey including the State- and Federally-listed delta smelt and marked declines of threadfin shad and State-listed longfin smelt.

6. Describe how the objectives were met:

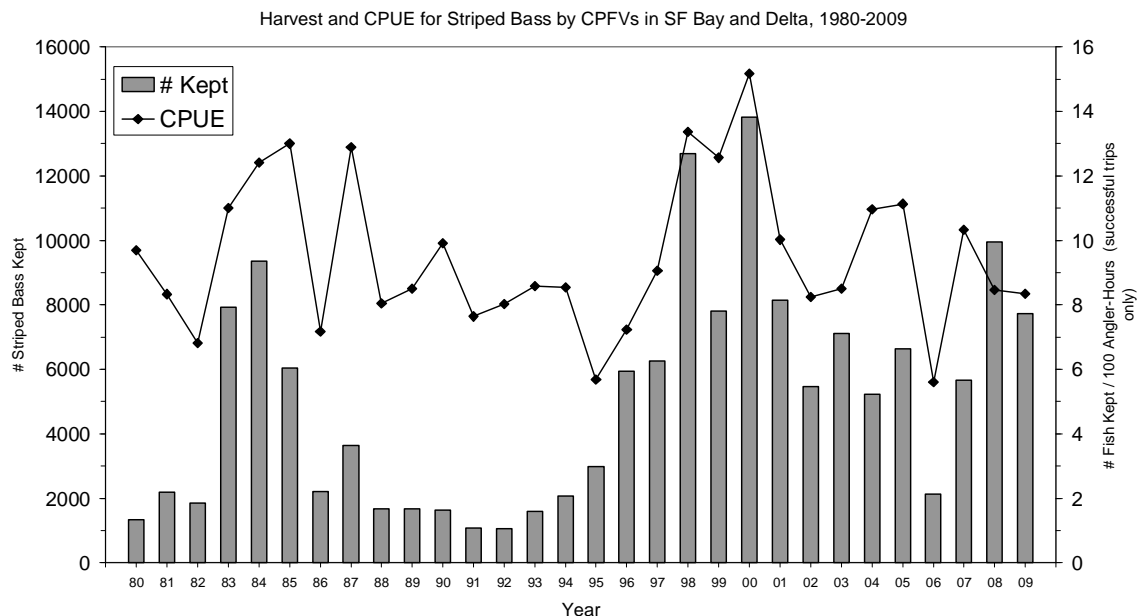
Job #1: Summer Abundance of Juvenile Striped Bass — We made necessary field collections and performed necessary laboratory work. Summer Tow Net Survey index of age-0 striped bass abundance in 2009 decreased slightly to 0.8 from 1.1 in 2008 and remains near the record low (see embedded figure below).



Job #2: Fall Abundance of Juvenile Striped Bass — We made necessary field collections and performed necessary laboratory work. The Fall Midwater Trawl Survey index of age-0 striped bass abundance in 2009 decreased to 70 from 220 in 2008 and remains near the record low (see embedded figure below).



Job #3: Age Composition and Population Size of Striped Bass in California's Sacramento Estuary — We conducted all aspects of a mark-recapture study and summarized catch from the Commercial Passenger Fishing Vessel fleet (see embedded figure below).



During April and May 2010, the Sport Fish Unit placed fyke traps into the Sacramento River near Knights Landing to capture adult striped bass. Fyke trap fishing efforts caught 2,952 striped bass of which 1,823 were then tagged and released (Attachment 1).

Job #4: Exploitation and Survival Rates of Striped Bass in California's Sacramento-San Joaquin Estuary — Laboratory staff completed database entries and mailed commemorative cards to anglers who returned tags from striped bass.

We conducted a thorough assessment and summary of the entire harvest rate and survival rate time series, thereby identifying strengths to preserve and weaknesses to address (Attachment 2).

7. Discuss differences between work anticipated in grant proposal and grant agreement, and that actually carried out with Federal Aid grant funds; include differences between expected and actual costs.

Job #1: Summer Abundance of Juvenile Striped Bass — No differences between work planned and work performed.

Job #2: Fall Abundance of Juvenile Striped Bass — No differences between work planned and work performed.

Job #3: Age Composition and Population Size of Striped Bass in California's Sacramento Estuary — Due to restrictions on hiring and an Executive Order forcing us to work 85% of full time, we were not able to use gill nets to capture striped bass for tagging and could not maximize catch of striped bass by fyke traps. Also due to hiring restrictions, we were not able to complete laboratory work to age striped bass from the samples of scales we collected and thus could not calculate abundance, harvest and survival rate estimates. We have (however) made progress aging the striped bass and expect to make abundance, harvest and survival rate estimates before June 2011.

Job #4: Exploitation and Survival Rates of Striped Bass in California's Sacramento-San Joaquin Estuary — See above.

8. List any publications or in-house reports resulting from this work.

DuBois, J. 2010. Adult Striped Bass Harvest and Survival Rate Estimates: A Forty-Year Summary and Methodology Review. IEP Annual Conference presentation. Sacramento, California

DuBois, J., M. D. Harris, and T. Matt. 2010. 2010 Adult Striped Bass Tagging Cruise Report. California Department of Fish and Game. Bay Delta Region, 4001 North Wilson Way, Stockton, CA 95205

Loboschefskey, E., G. Benigno, T. Sommer, T. Ginn, A. Massoudieh, K. Rose, and F. Loge. 2010. Bioenergetic Modeling of Striped Bass Predation in California from 1969-2004. Peer-reviewed manuscript submitted.

Name, title, phone number, and e-mail address of person compiling this report:
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2010 Adult Striped Bass Tagging Cruise Report

California Department of Fish and Game
Bay Delta Region (Stockton)

by Jason DuBois, Michael D. Harris, and Tim Matt

July 1, 2010

Cruise Dates: April 19, 2010 – May 26, 2010

Introduction

An adult striped bass population study conducted by the California Department of Fish and Game (CDFG) has been ongoing since 1969. Part of the study is a “high-value” reward tagging program. Presented here is a summary of the 2010 striped bass-tagging field season.

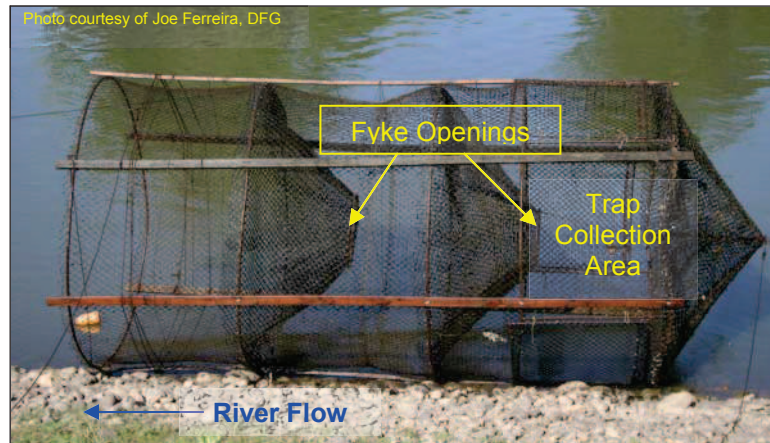
The tagging program is designed to understand and monitor the population dynamics of striped bass (*Morone saxatilis*), with the ultimate goal being to provide the tools to inform science-based resource management decisions. These tools include relative and absolute abundance, harvest rate, mortality rate, individual growth rates, and large-scale movement/migration patterns.

Our objective during the field season was to capture, tag, measure, sex, and release in good condition as many striped bass as possible and to document previously-tagged striped bass.

Methods and Gear

California Department of Fish and Game staff participated in this project (Appendix 1). The crew typically included one Associate Biologist, three Scientific Aides, and a Mate. Tagging was performed per procedure outlined in Appendix 2 of the Sacramento-San Joaquin Sport Fish Management Striped Bass Population Study Quality Control and Operating Manual.

Eight cylindrical fyke traps (length 20'; diameter 10') were fished in the Sacramento River near Knights Landing (see photo at right of a fyke trap). Five traps were placed on the east riverbank about two miles upstream of the Knights Landing Bridge (Highway 113). The remaining three traps were placed on the east riverbank about one mile downstream of the Knights Landing Bridge. Traps were placed approximately 50 to 150 feet apart from each other.



Traps were completely or near-completely submerged while fishing (collecting fish). Striped bass swam through the two openings (marked in photo above) and collected in the front (cone) of the trap. To remove fish from a trap, the trap was rolled up the riverbank until one of the doors was positioned in such a way as to facilitate easy access for tending the trap from the ~20-foot pontoon boat, the *Kayot*, while ensuring the trap remained in enough water to minimize fish stress.

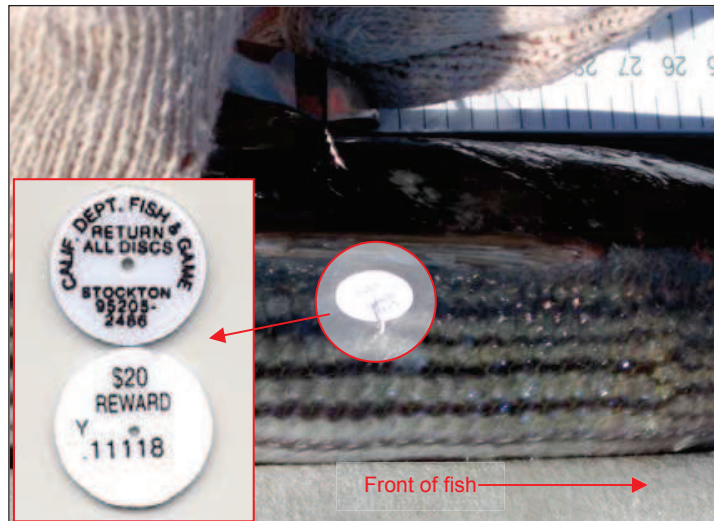
One of two methods was used to roll the traps up and down the riverbank: a cable-and-block system or an electric winch. When the trap and boat were in position, fish were netted from the trap and tagged on board the *Kayot*.



Striped bass were measured to the nearest centimeter fork length (cm FL). Most fish were sexed and fitted with a Petersen disk-dangler tag (see photo below of disc tag as it was applied to the fish; inset is example of the two sides of the tag).

Each tag possessed a unique 6-digit numeric or alpha-numeric identifier and the location of the Fish and Game office to where the tag should be returned. To evaluate return-rate, ~10% of all tags applied offered rewards of \$20 (example shown), \$50, or \$100.

For recaptures (i.e., fish possessing tags from previous years), length, sex, and tag number were recorded.



All fish were processed at and returned to the location of capture, and condition (general health) of the fish was noted upon return to the water.

Not all captured striped bass were tagged. Dead fish were recorded accordingly and added to the total catch. Fish in poor condition were released without a tag, recorded as “over”, and added to the total catch. Healthy fish that could not be tagged safely (e.g., due to time constraints) were enumerated, measured, and sexed but not tagged¹; scales were collected from some.

Results

The season started late and lasted six weeks, beginning April 19 and ending May 26. The season typically starts the beginning of April, but was delayed in part due to rains that made the terrace unworkable.

Field days were Monday through Thursday and tagging occurred Tuesday through Thursday. To comply with requirements of the National Marine Fisheries Service, each trap was fished no more than one day before being inspected for listed fishes. Field days began at 0900 and ended at 1700 or earlier, and varied depending on the number of fish caught and/or the number of available personnel.

Fyke traps were deployed 17 days, inspected each day for the presence of listed fishes, and tended 72 times (Table 1). On average, traps fished 23.5 hours per day (range: 17.75 – 28.25 hours).

The total number of striped bass caught was 2,952, of which 1,823 (395 were sub-legal²) were then tagged (Table 1). Five fish were recaptures from previous tagging seasons (one from 2008 and four from 2009). Twenty-four fish were recorded as “over” and 1,094 were creeled.

¹ We described these fish as having been “creeled”.

² < 42 cm FL

Table 1. Summary of fyke trap effort and striped bass catch during 2010

	Total Caught	Total Tagged	# Traps Fished	# Traps Tended	# Days Fished
Total	2,952	1,823	125	72	17
Daily Minimum	17	0	6	1	N/A
Daily Maximum	814	329	8	8	N/A
Daily Average	197	122	7	5	N/A
Minimum/Day/Trap	0	0	N/A	N/A	N/A
Maximum/Day/Trap	748	282	N/A	N/A	N/A
Average/Day/Trap	46	34	N/A	N/A	N/A

A tended trap = fish handled and removed from the trap

Not all traps fished were tended. If the trap had few striped bass and no ESA species, the trap was rolled back into the water without handling fish.

Of the fish that were caught and for which a length measurement was recorded (N = 2,845), length ranged from 30 to 113 cm FL and averaged 46 cm FL. Males were more abundant than females. Of the fish that were caught and for which sex was recorded (N = 2,824), 2,778 were male and 46 were female (~60 males to 1 female). On average, females were larger in length (♀ = 59 cm FL, ♂ = 46 cm FL).

Daily average river stage for the Knights Landing-portion of the Sacramento River was calculated from hourly readings posted on-line at the California Data Exchange Center's website. Stage declined over the course of the season (Figure 1). Water temperature was recorded by field crew at the beginning of each tagging day (Figure 2). Average water temperature was 17 degrees Celsius (°C, or about 63 degrees Fahrenheit) for the tagging season.

Striped bass catch per trap-hour³ by day was calculated and plotted against river stage (Figure 1) and water temperature (Figure 2). Average catch per trap-hour for the tagging season was 1.17 fish. Seven days were above this average.

³ Rounded to nearest ¼-hour and cumulative for the number of traps fishing (for example, if 10 traps each fished 24 hours in one day, then trap-hours for that day equaled 240.) Catch includes any fish left in the trap from the preceding day.

Figure 1. Daily average stage at Knights Landing versus striped bass catch per trap-hour by day

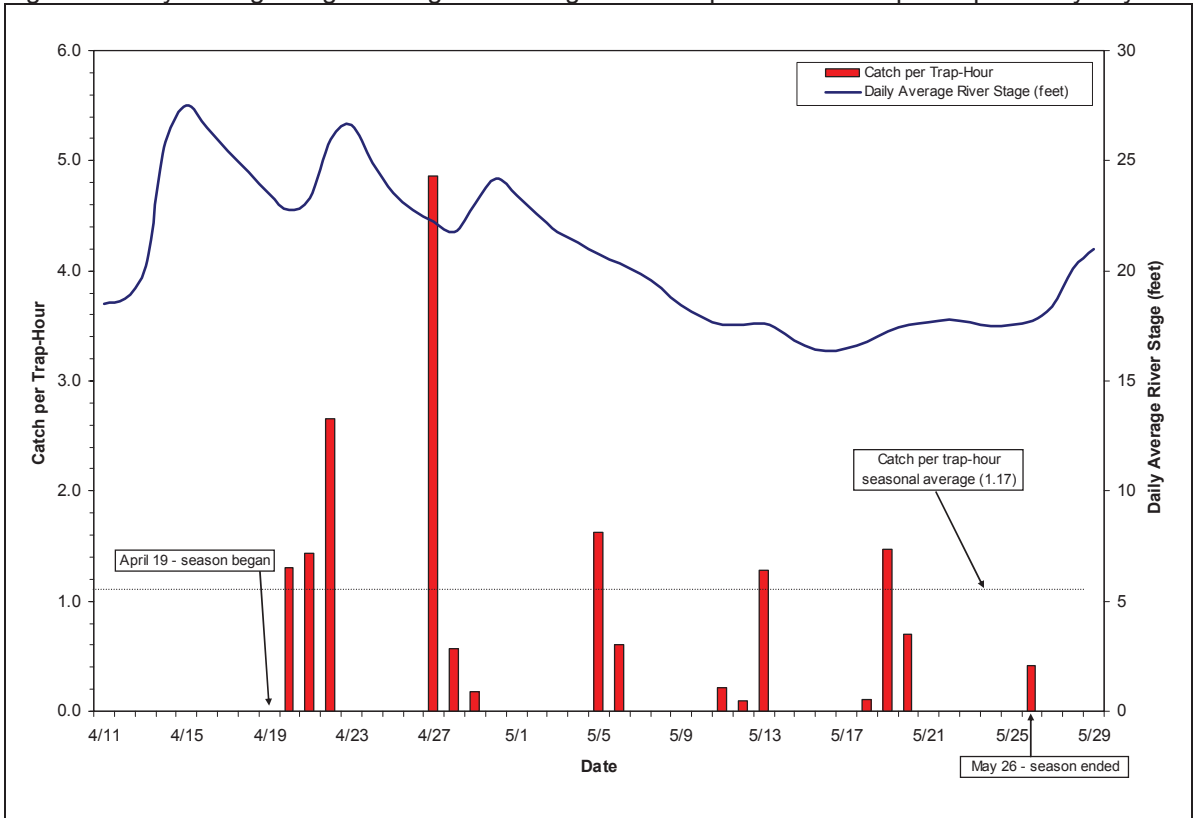
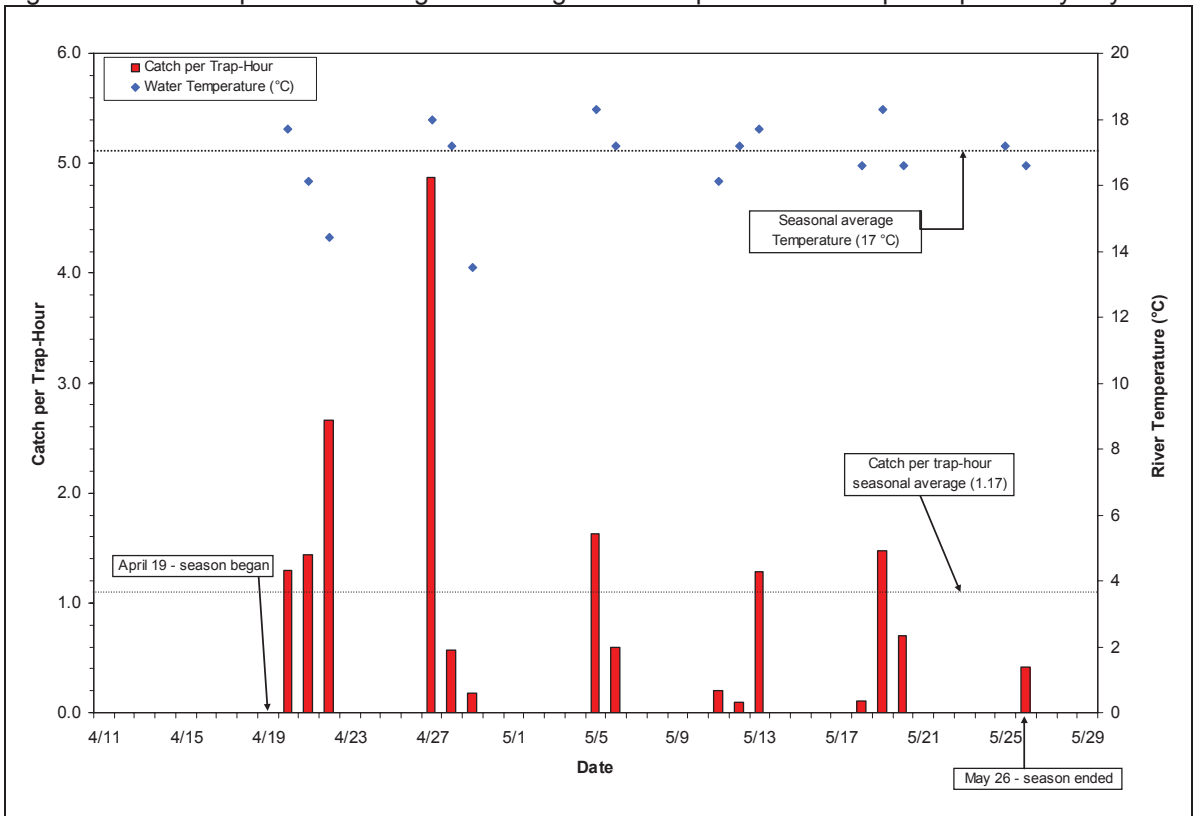


Figure 2. Water temperature at Knights Landing versus striped bass catch per trap-hour by day



The majority of striped bass were caught during the first two weeks of the season (Table 2). Average fork length of tagged fish remained fairly consistent from week to week. Sub-legal sized fish were 16% of total catch.

Table 2. Summary of fyke trap effort and striped bass catch in 2010

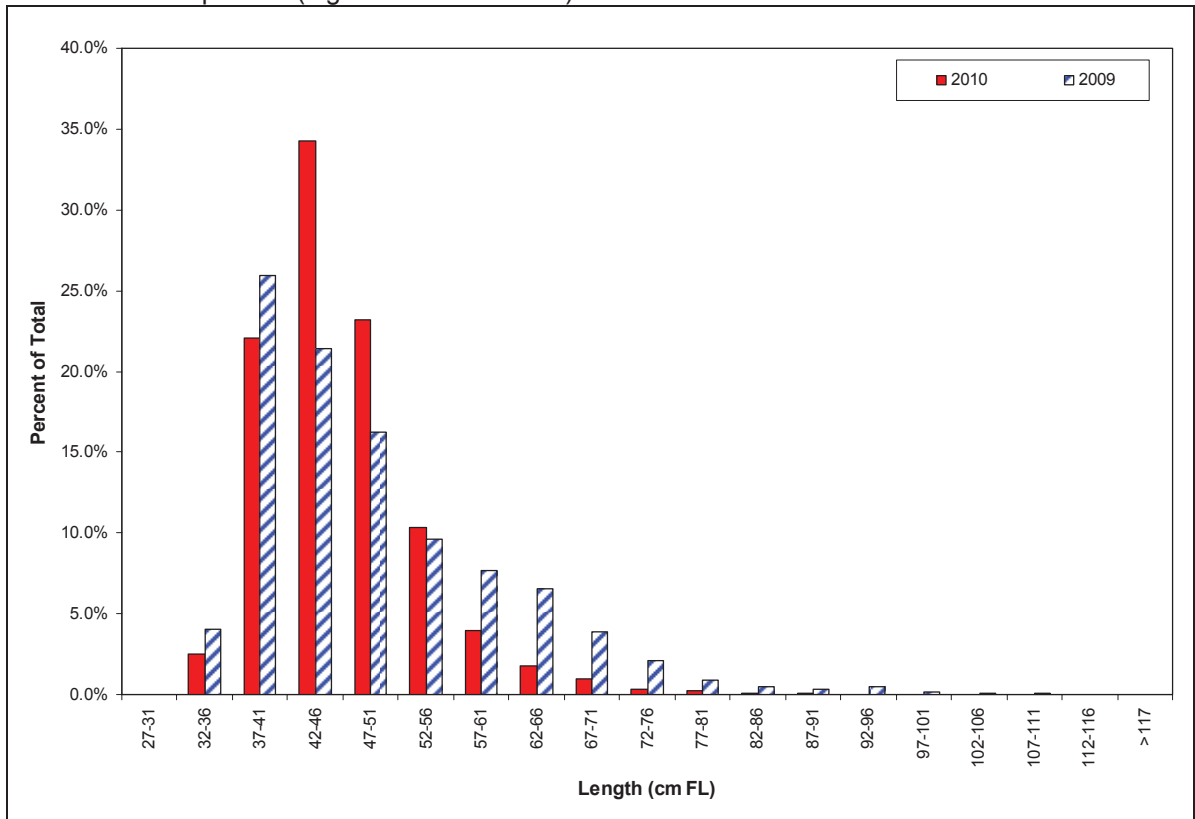
Week	1	2	3	4	5	6
Tagged	389	354	267	300	435	78
Creeled	444	571	79	0	0	0
Over	4	7	7	1	4	1
Dead	0	0	4	2	0	0
Recapture (from previous seasons)	1	1	1	2	0	0
Weekly Total Catch	838	933	358	305	439	79
Number of Traps Tended	13	19	11	13	10	6
Number of Days Fished	3	3	3	3	3	2
Minimum FL (cm)	30	32	33	35	32	33
Maximum FL (cm)	87	113	78	88	100	67
Average FL (cm)	47	46	46	46	47	49

Week 1 creeled includes 59 fish < 42 cm FL.

Of the total creeled (N = 1,094), 82 were dead.

Nearly 80% of all striped bass caught and measured were between 37 and 51 cm FL (Figure 3). More large fish (> 56 cm FL) were caught in 2009 (23%) than in 2010 (8%). Fish between 57 and 71 cm FL were observed most frequently in Week 6 (Appendix 2).

Figure 3. Length frequency of all striped bass collected in fyke traps during 2010; 2009 data included for comparison (legal size: ≥ 42 cm FL)



Listed Species and other By-catch

Only one ESA-listed fish (a Chinook salmon) was caught this season (Table 3; caught May 20). The salmon was in excellent condition with bright coloration (guesstimated length = 50 cm).

All other by-catch was noted (Table 3). American shad was the dominant by-catch.

Table 3. By-catch of the 2010 striped bass tagging season

Other Species (common name)	Scientific Name	Total Count
American Shad	<i>Alosa sapidissima</i>	300
Carp	<i>Cyprinus carpio</i>	4
Channel Catfish	<i>Ictalurus punctatus</i>	8
Chinook Salmon	<i>Oncorhynchus tshawytscha</i>	1
Sacramento Sucker	<i>Catostomus occidentalis</i>	1

Discussion

Average catch per trap-hour was about five times higher than in 2009 (1.17 versus 0.22), which suggests the abundance of striped bass in the reach was greater this year than last.

Fewer striped bass were tagged this season (N = 1,823) than ever before, a fact attributable in part to reduced fishing effort due to (1) a late start to the tagging season, (2) mandatory furlough days, (3) limited personnel, which precluded fishing traps more often and catch via gill nets that is usually an integral part of this program.

Acknowledgements

We recognize and give a very special thanks to our friends at *StingRayz Beach Boardwalk and Marina* in Knights Landing. They generously allowed us to berth the *Kayot* at their marina.

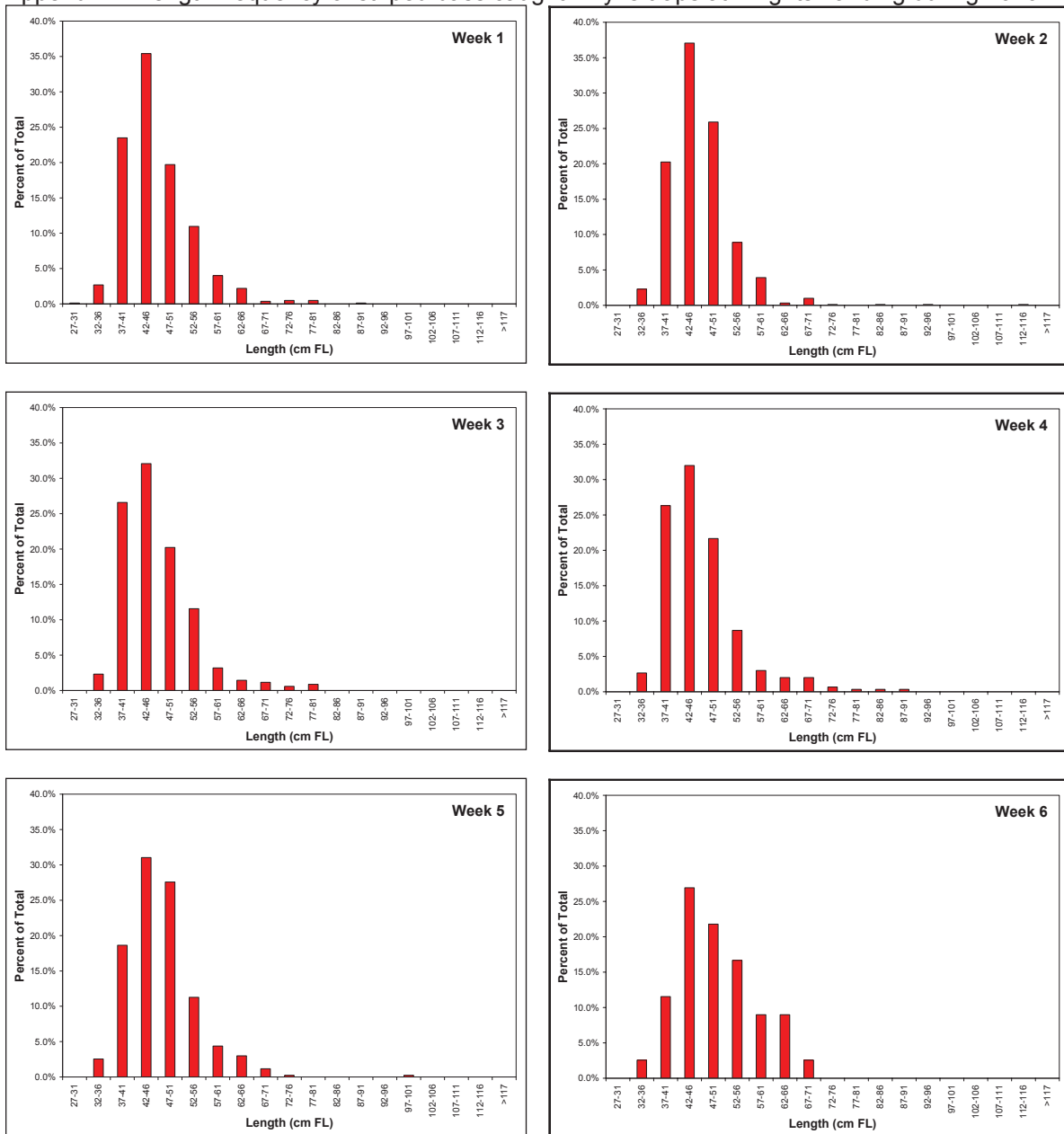
We thank Mr. Jack Bailey (Reclamation District 1500) for his efforts in presenting to the trustees of Reclamation District 1500 and to local landowners our request for access to the Sacramento River through various properties. His efforts allowed us to begin our fieldwork in a timely manner.

Last but not least...we thank all personnel involved in this project. Their commitment and hard work ensured the collection of sound scientific data.

Appendix 1. Personnel list. All were employees of the California Department of Fish and Game (Bay Delta Region, 4001 N. Wilson Way, Stockton, CA 95205)

Name	Position Title
Brian Delano	Mate
Jason DuBois	Associate Biologist
Dan Fidler	Scientific Aide
Marty Gingras	Supervising Biologist
Mike Harris	Associate Biologist
Tim Matt	Scientific Aide
Leo Millan	Mate
Katie Smith	Scientific Aide
Ramiro Soto	Mate

Appendix 2. Length frequency of striped bass caught in fyke traps at Knights Landing during 2010



Adult Striped Bass Harvest and Survival Rate Estimates: A Forty-Year Summary and Methodology Review

Jason DuBois, CDFG
IEP Conference, Sacramento
May 26, 2010

Adult Striped Bass

Harvest and Survival Rate Estimates

- Overview of Tagging Program (Mark-Recapture)
- Equations
- Annual Estimates and Potential Biases

Adult Striped Bass Mark-Recapture Study

- Ongoing since 1969
- Provide estimates
 - Absolute abundance
 - Rates of harvest and survival
- Use fyke traps and gill nets
- Sacramento River (Knights Landing)
- San Joaquin River (Schad Landing)

Adult Striped Bass

Mark-Recapture Study

- Tag: [Petersen disc tag](#)
 - Applied to fish legal size and above
 - Applied on right-side, below first dorsal fin
 - Non-reward and [reward](#)
- Record fork length (cm), sex, condition
- Collect scale sample for aging
- Tagging during spawning migration
- Tag as many as possible



"Return all
discs to Fish
and Game"
appears on
every tag

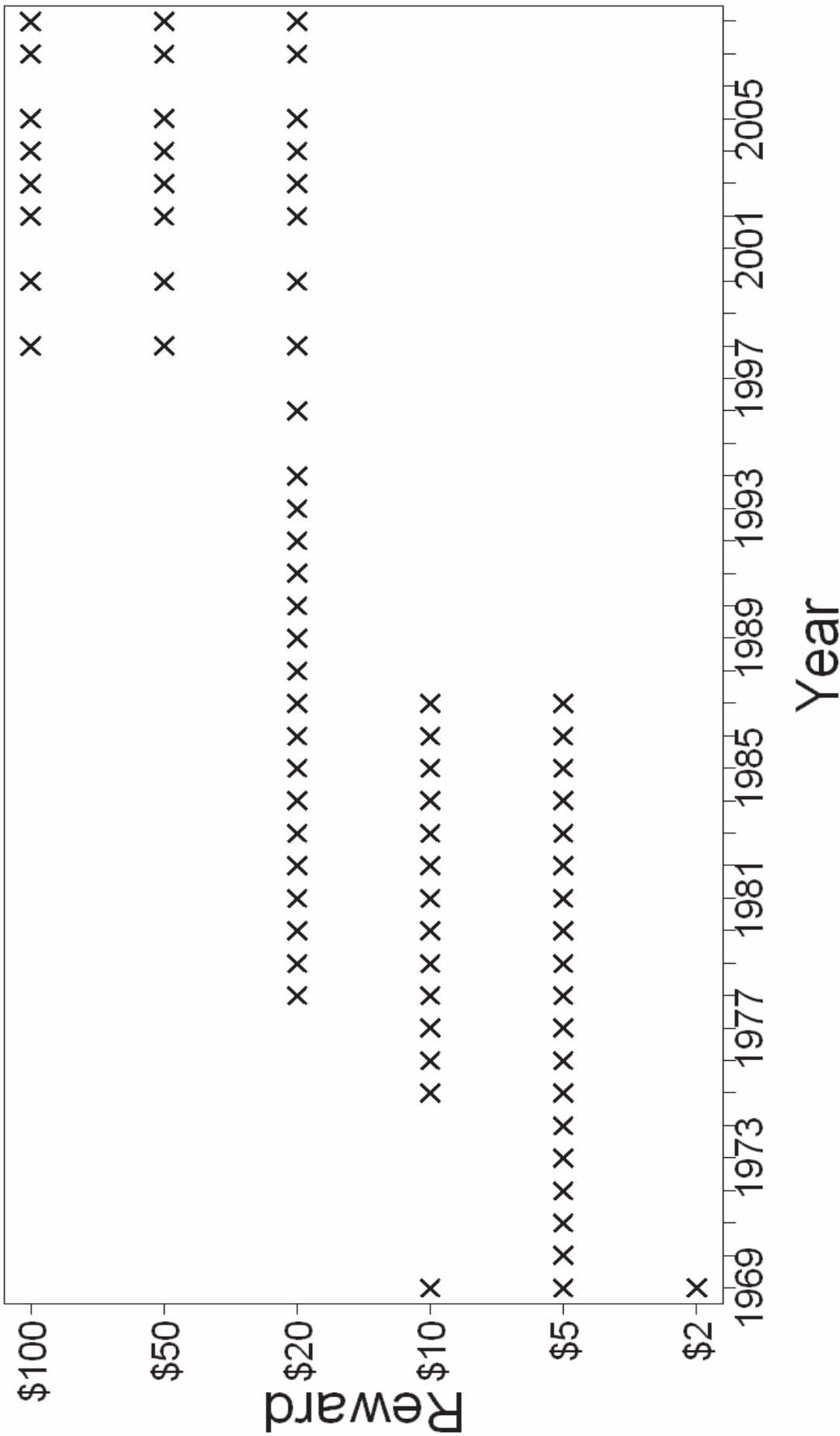
6-digit
numeric
non-
reward
tag

\$20
reward
tag

\$50
reward
tag

\$100
reward
tag

Adult Striped Bass Reward Tag Timeline



Adult Striped Bass

Mark-Recapture Study

- Recaptures
 - By angler
 - Subsequent tagging seasons
- Angler Tag Returns
 - Mail
 - Creel survey

Adult Striped Bass Return Rate Equation

- R_i = number of *first-year* mail tag returns from group M_i
- M_i = number of tags released
- i = tag value

$$\hat{f} = \frac{R_i}{M_i}$$

Adult Striped Bass

Response Rate Equation

- Ratio of return rate of non-reward tag (nr) to reward tag (r)
- Ratio corrects for non-response

$$\hat{r} = \frac{\hat{f}_{nr}}{\hat{f}_r}$$

Adult Striped Bass

Harvest Rate Equation

- Harvest Rate
- $R_{\text{(mail)}}$ = number of first-year non-reward tags returned by mail
- $R_{\text{(creel)}}$ = number of first-year non-reward tags collected during creel survey
- $r_{\text{(min)}}$ = minimum estimated response rate
- M = number of non-reward tags released
- i = year

$$\hat{\mu} = \frac{\left(\frac{R_{\text{(mail)}}_i}{\hat{r}_{\text{(min)}}_i} + R_{\text{(creel)}}_i \right)}{M(i)}$$

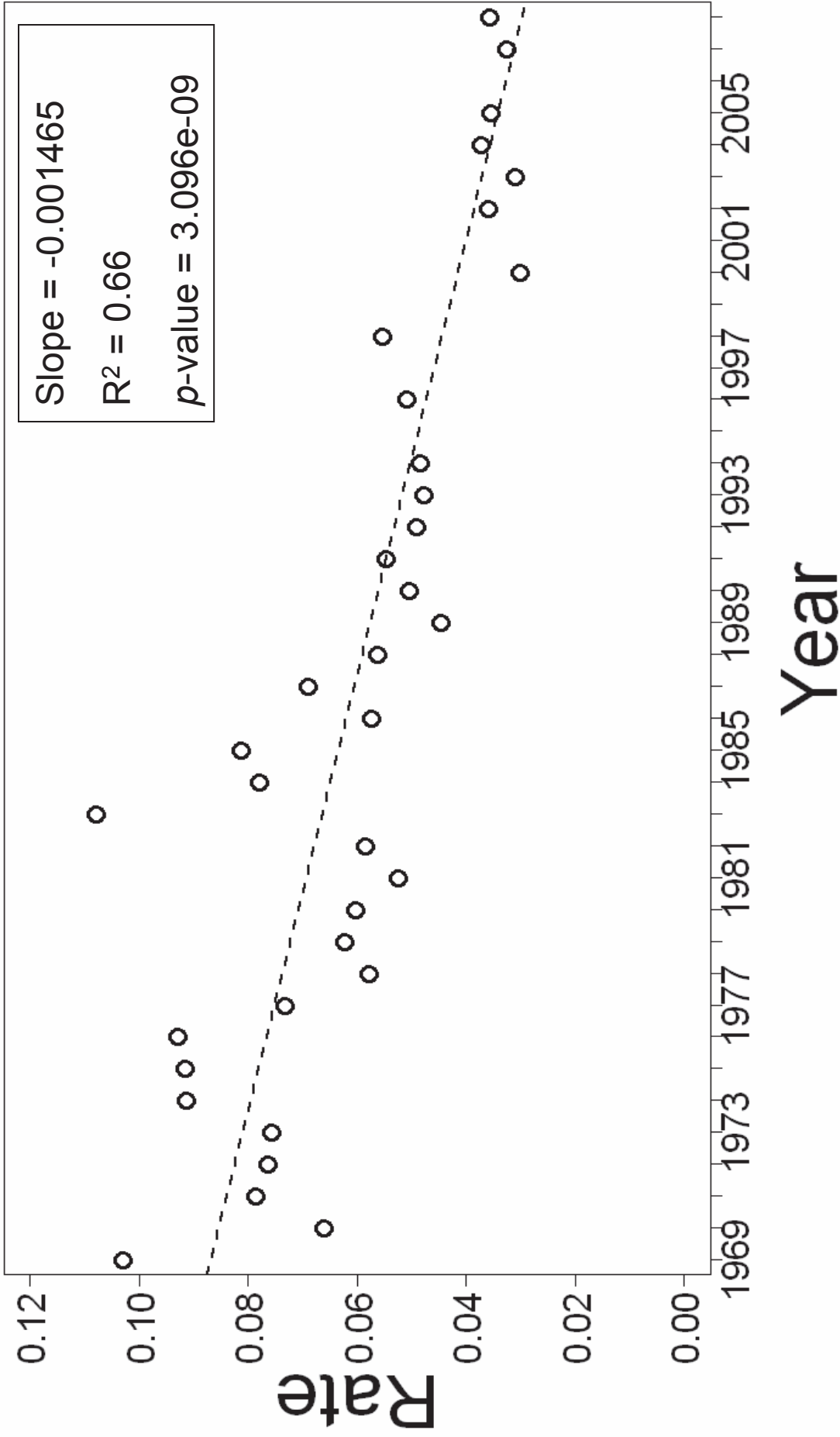
Adult Striped Bass (ASB)

Survival Rate Equation

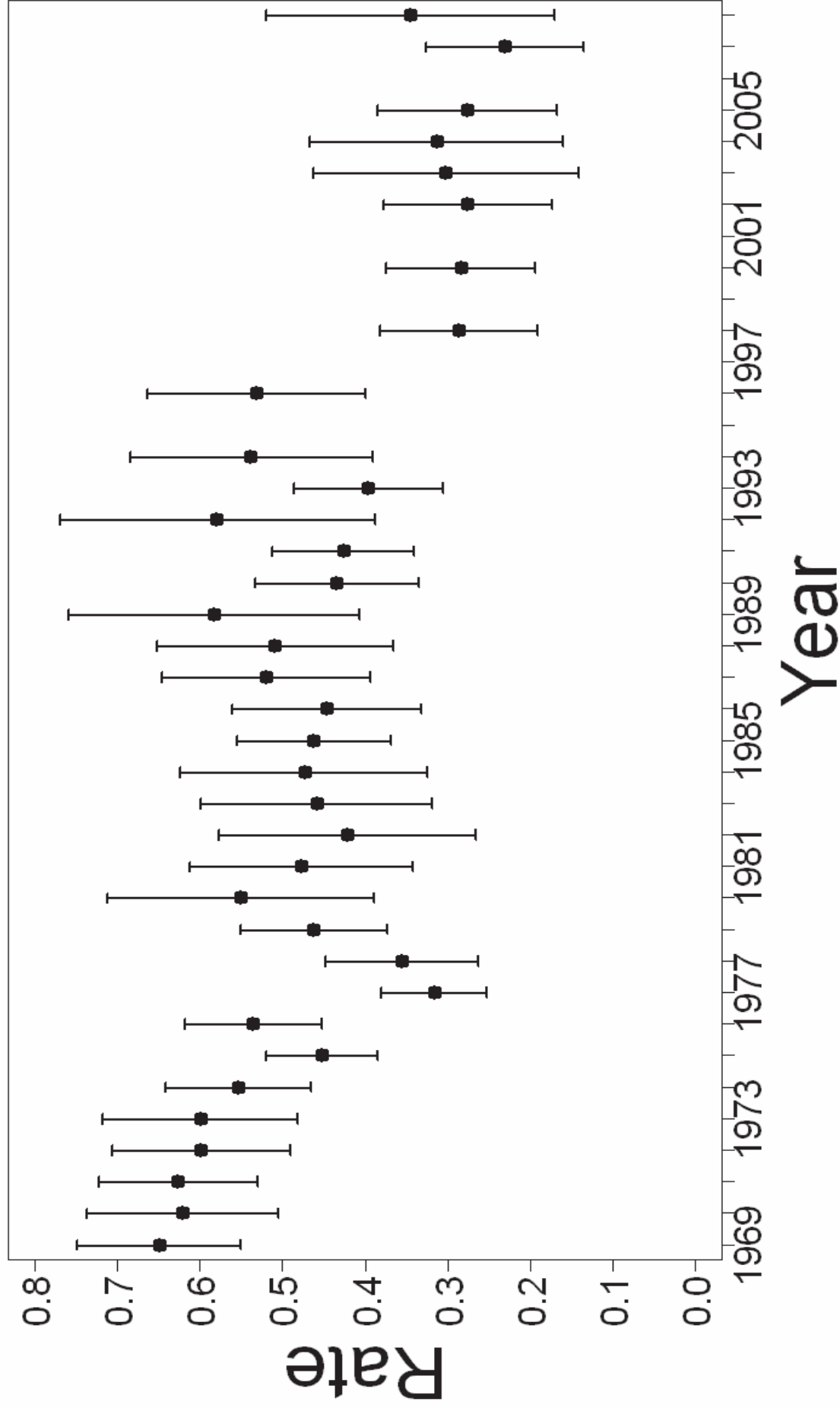
- Survival Rate (\hat{S})
- Ricker Equation 5.1
- R_{12} = recapture of year X tags in year X+1, post start of tagging (second-year tag returns)
- M_2 = number of striped bass tagged in year X+1
- M_1 = number of striped bass tagged in year X
- R_{22} = recapture of year X+1 tags in year X+1

$$\hat{S} = \frac{(R_{12}) \times (M_2)}{(M_1) \times (R_{22})}$$

Adult Striped Bass Annual Mail Return Rate (Non-Reward Tag)

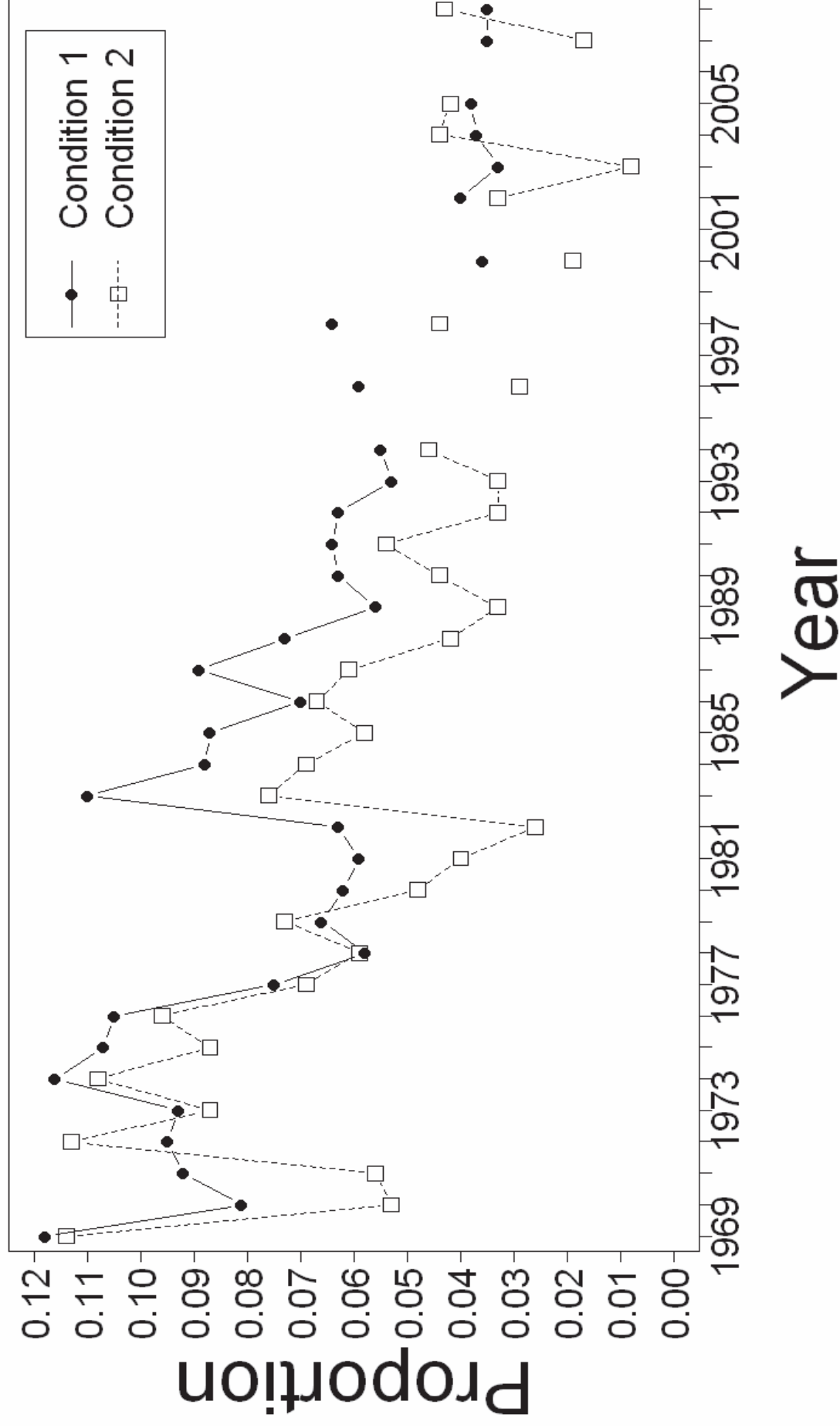


Adult Striped Bass Annual Response Rate Estimates



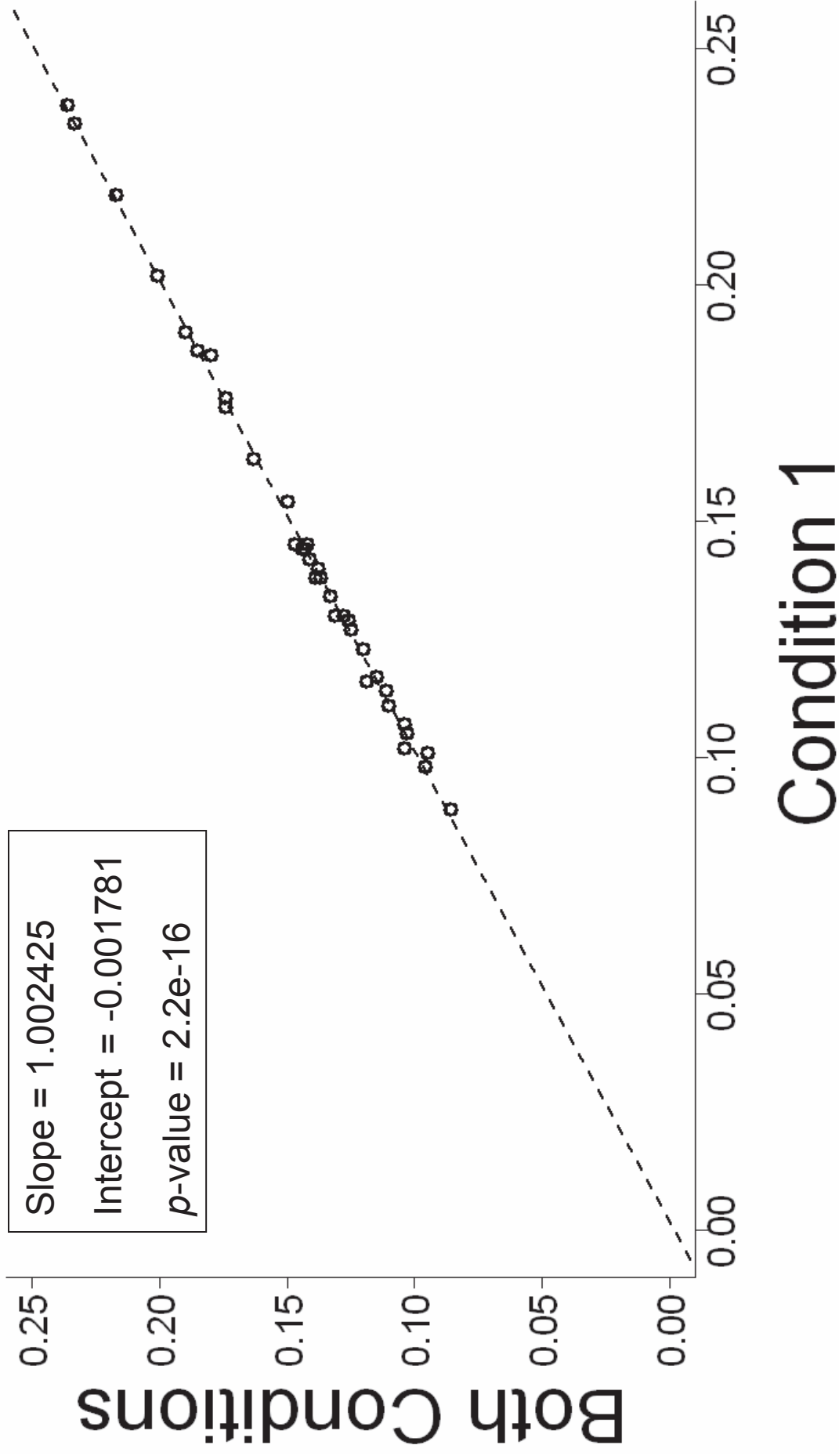
Adult Striped Bass

Proportion of Tag Returns



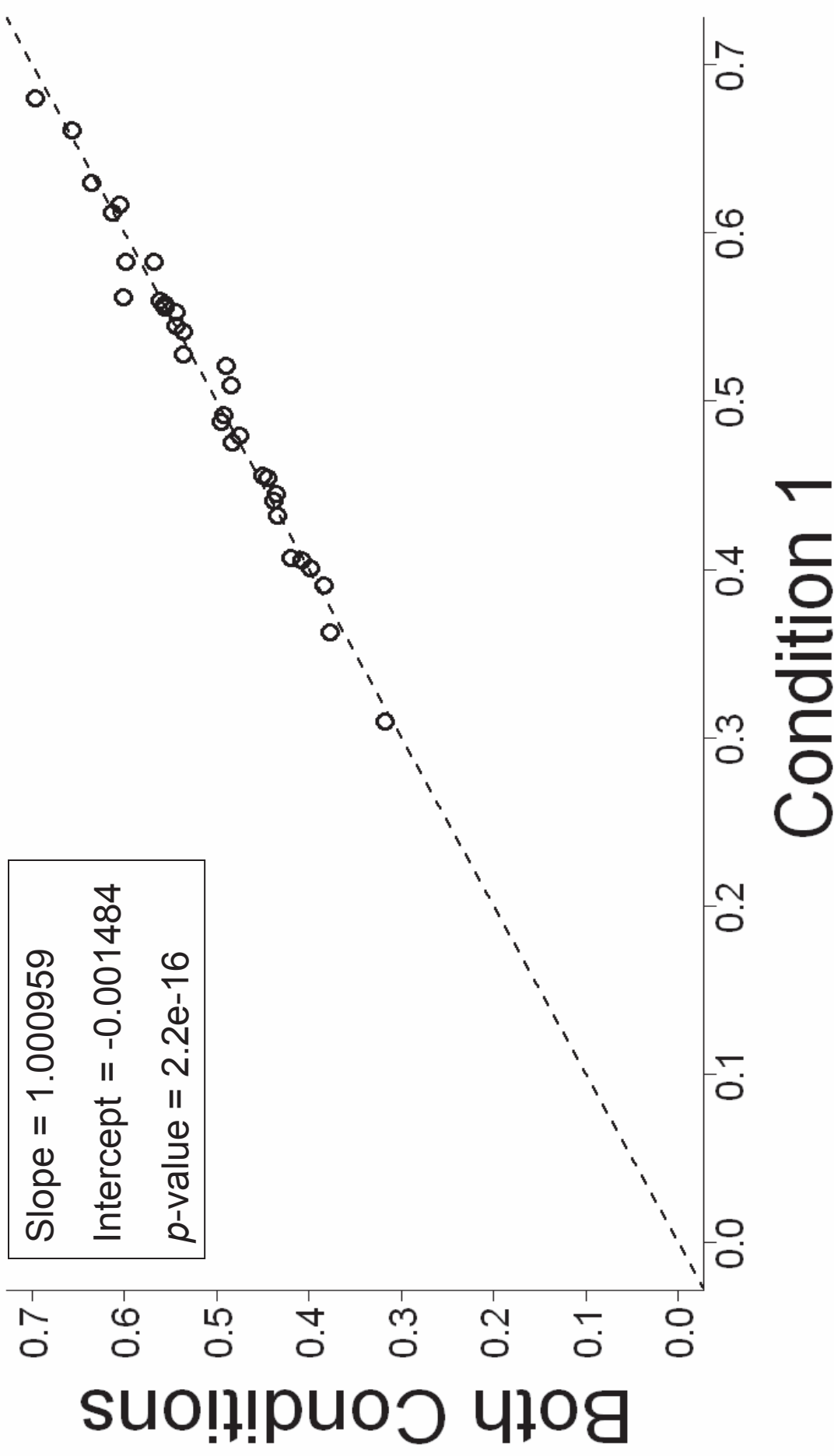
Adult Striped Bass

Harvest Rate (condition comparison)

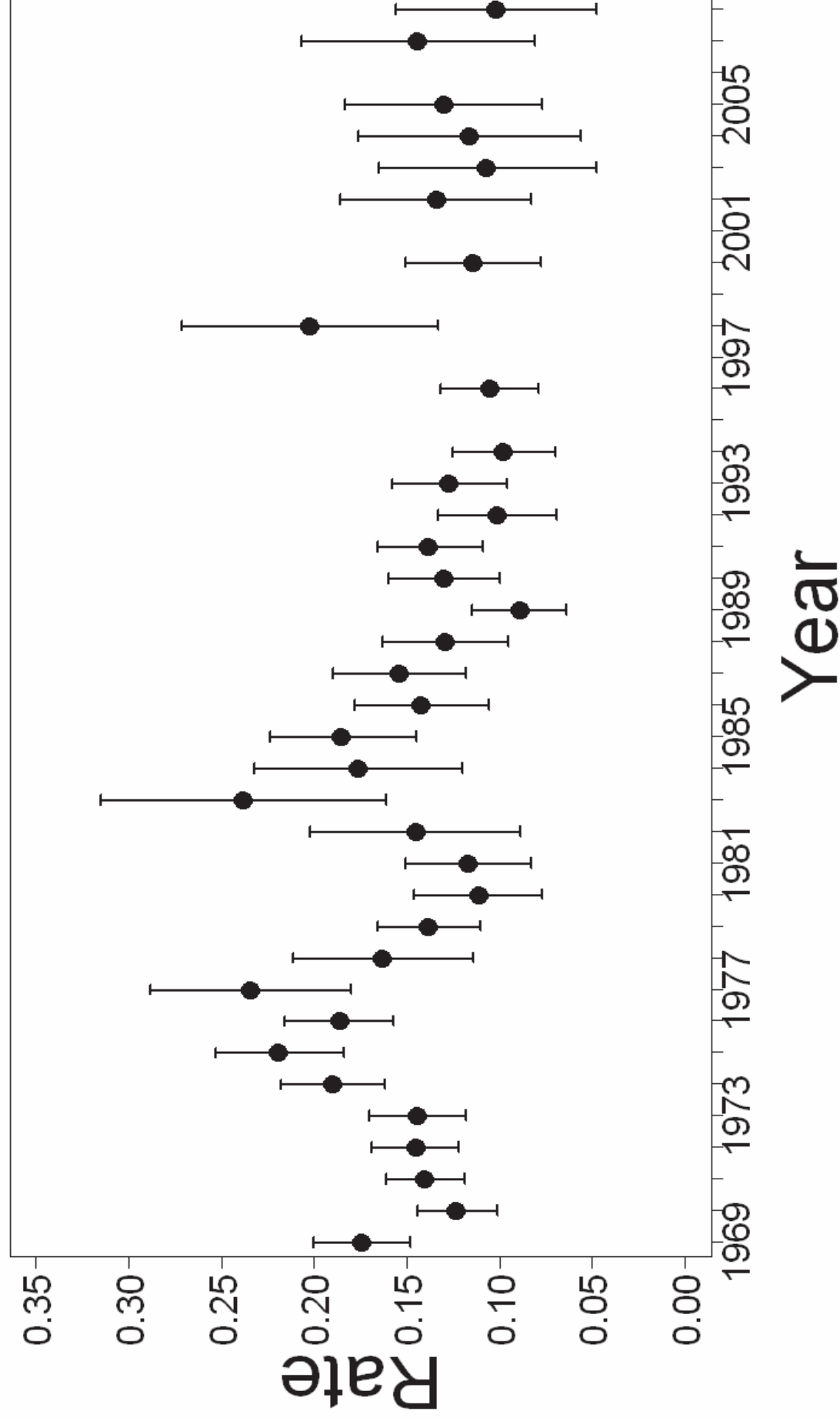


Adult Striped Bass

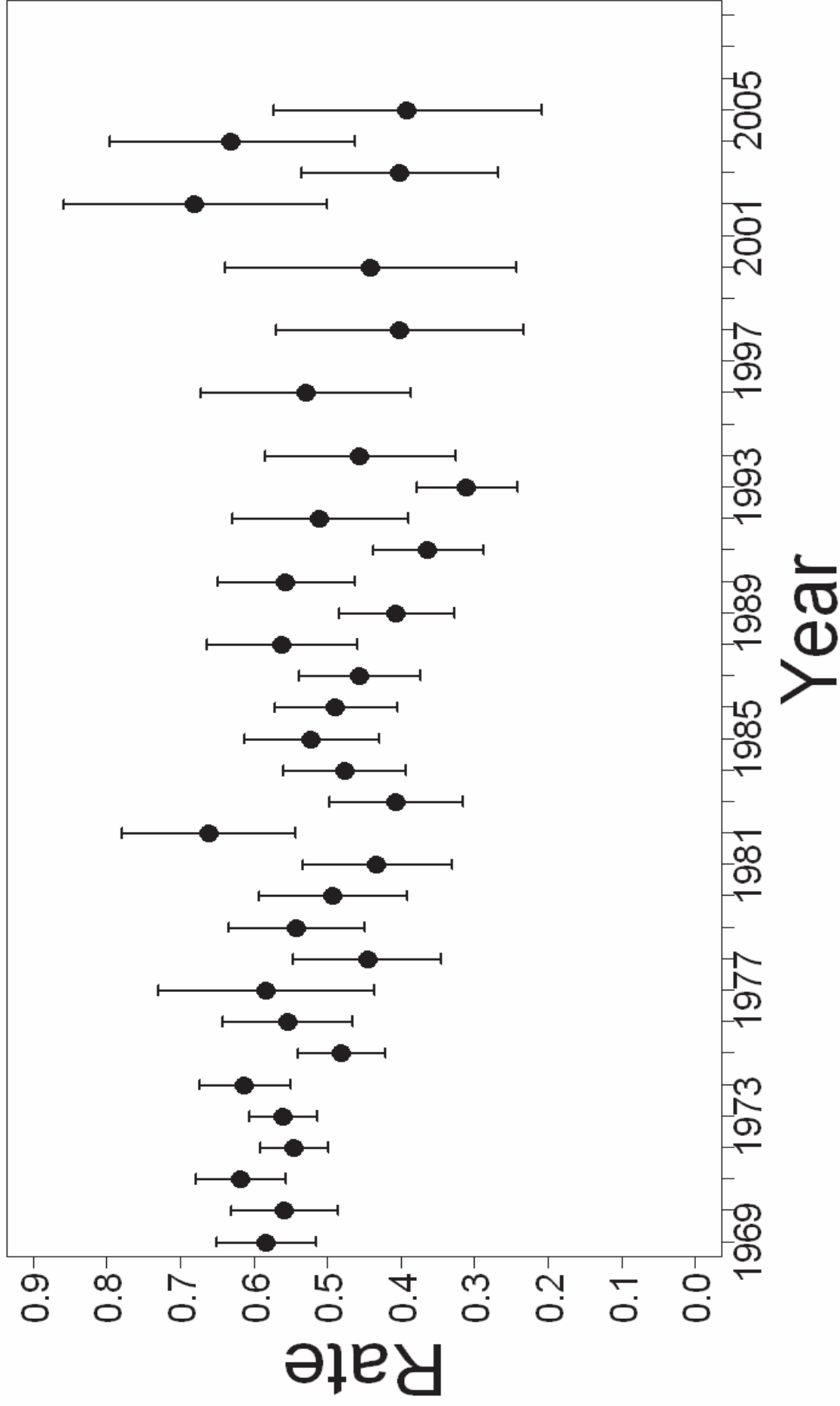
Survival Rate (condition comparison)



Adult Striped Bass Annual Harvest Rate Estimates

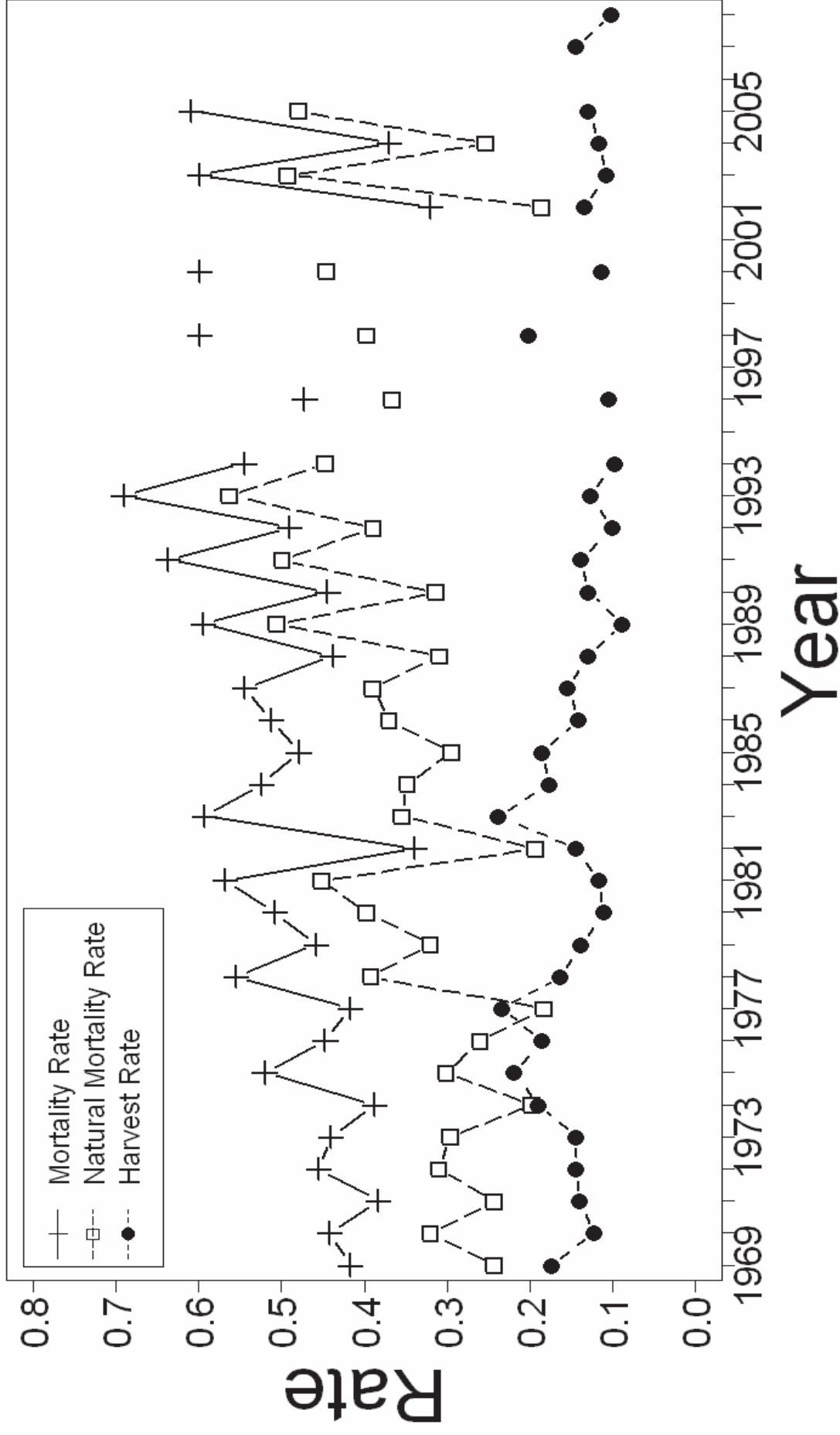


Adult Striped Bass Annual Survival Rate Estimates



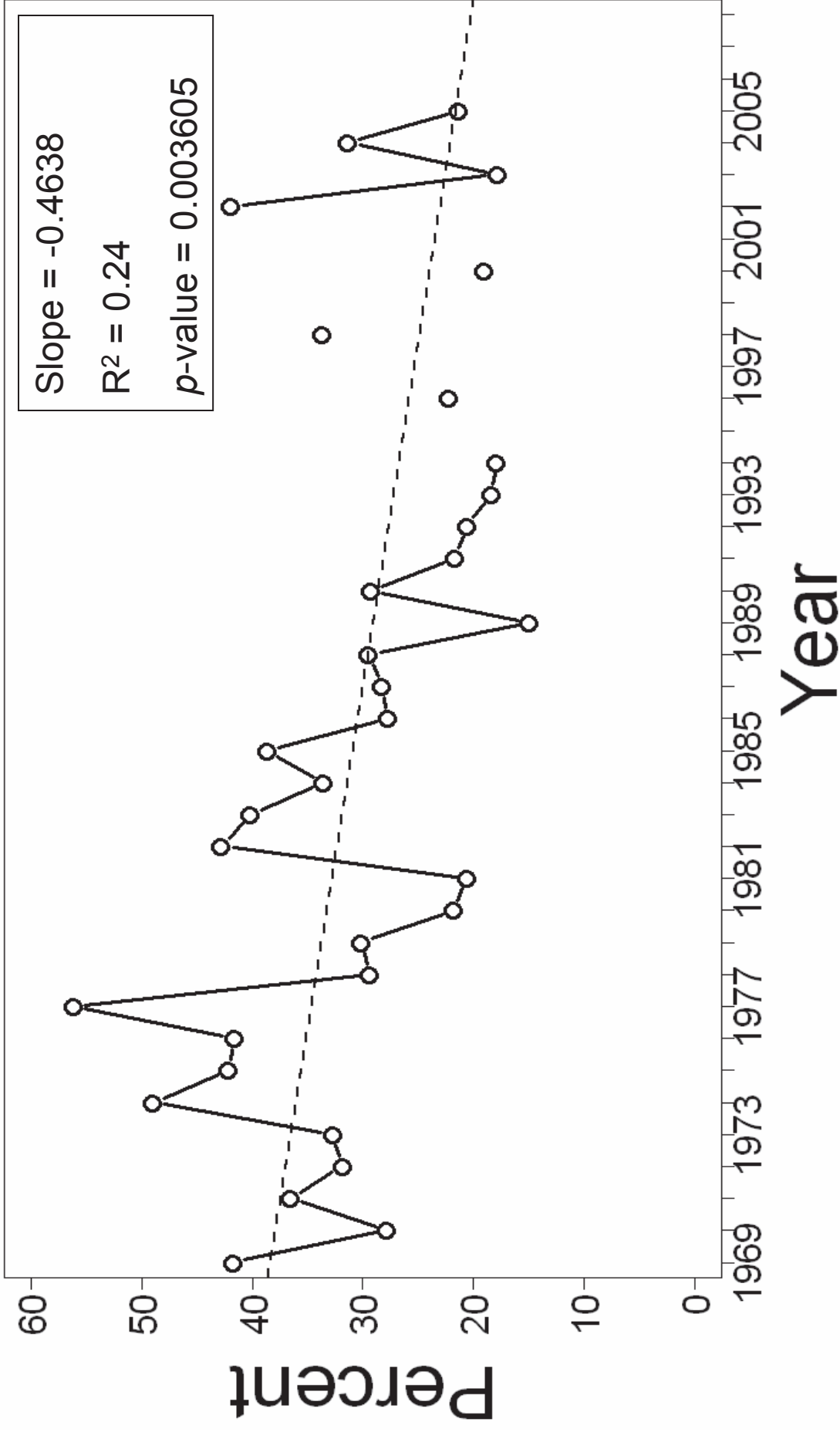
Adult Striped Bass

Annual Mortality, Natural Mortality, Harvest



Adult Striped Bass

Harvest Rate as a Percent of Mortality Rate

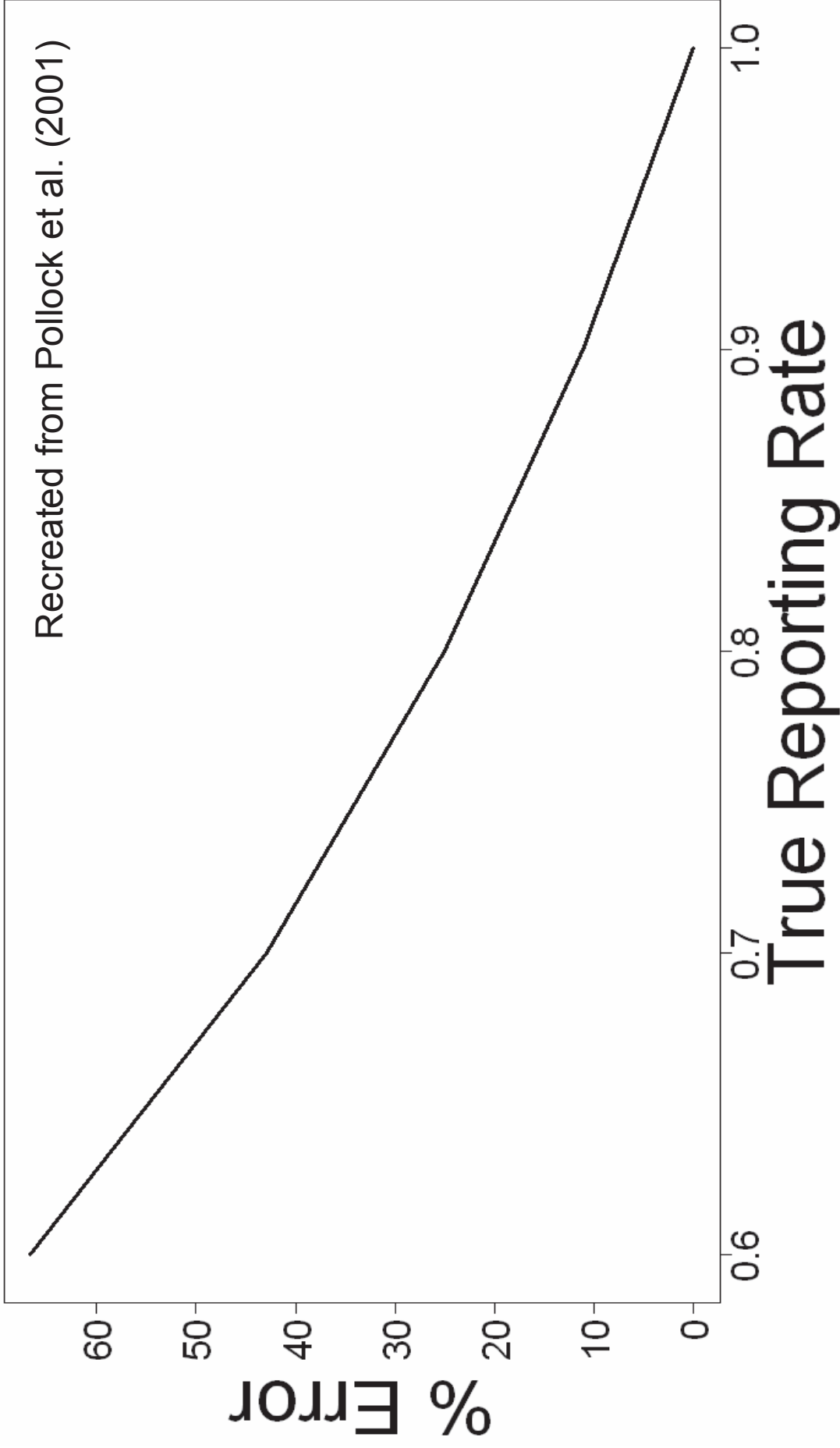


Adult Striped Bass Mark-Recapture Study

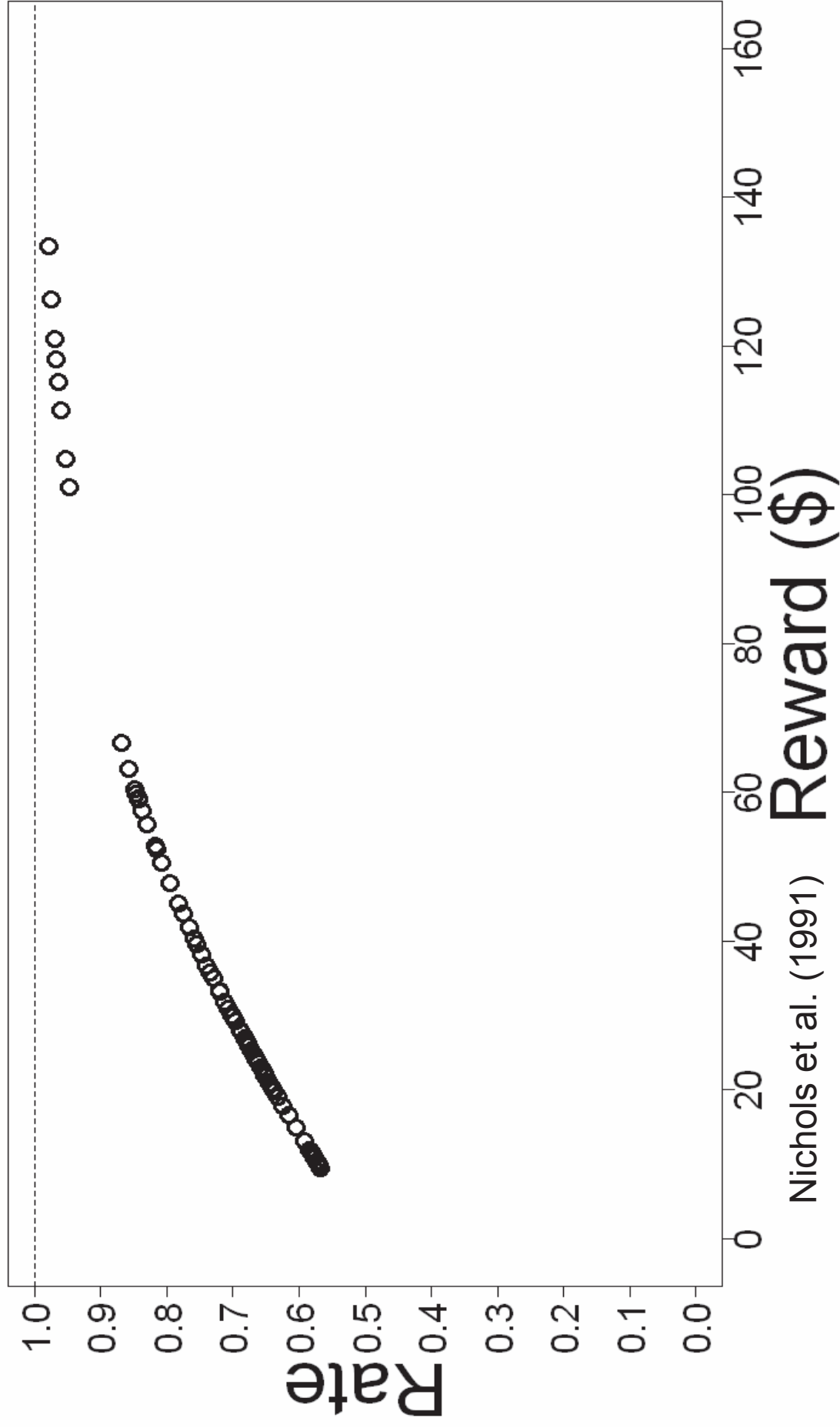
- Potential Biases within Estimates
 - Under reporting of reward tag
 - Reward too low

Adult Striped Bass

Percent Error of Reporting Rate Estimate

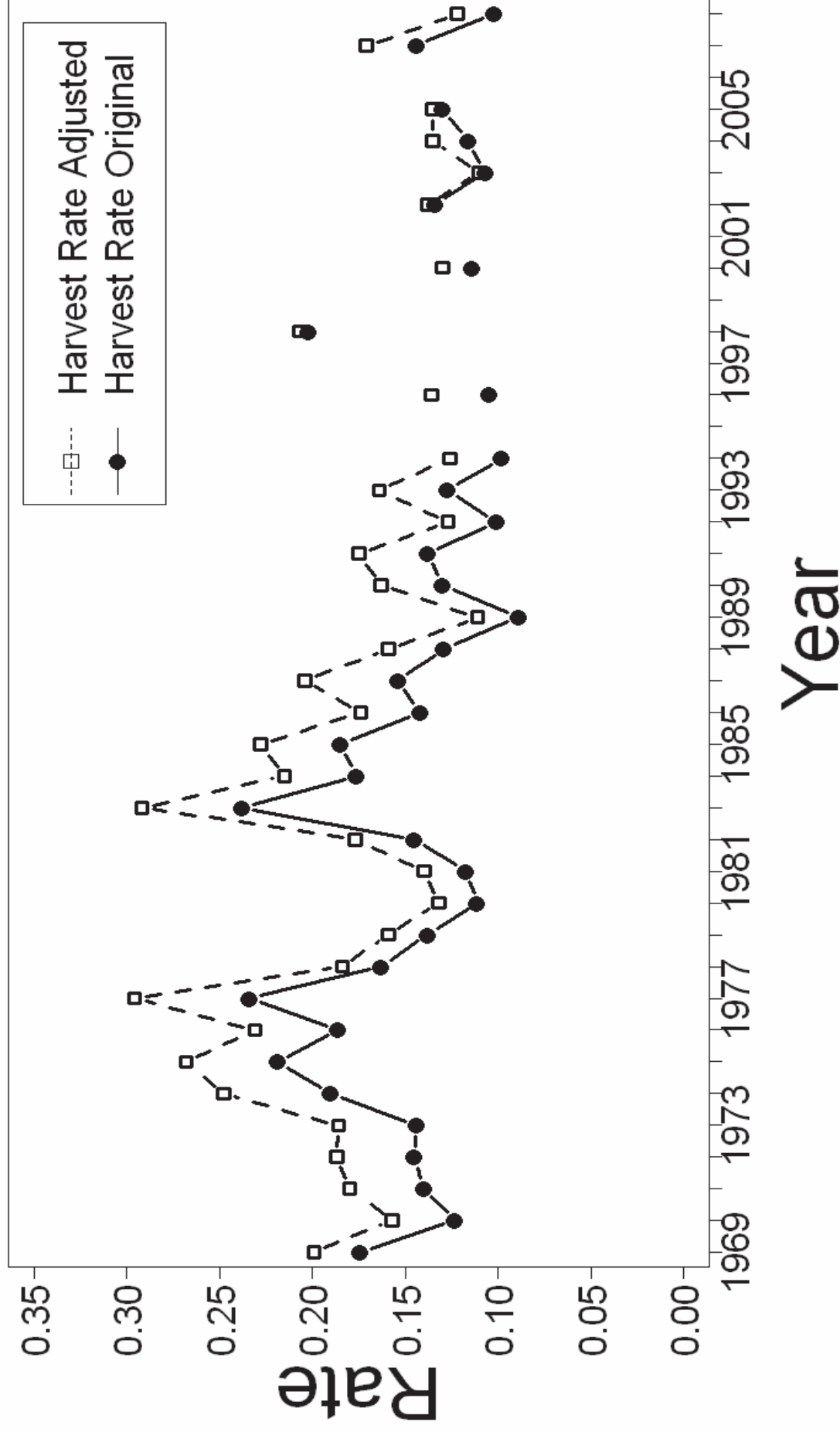


Adult Striped Bass Estimated Reporting Rate



Adult Striped Bass

Annual Harvest Rate Estimates



Adult Striped Bass

Conclusion & Recommendations

- Reliable estimates of harvest and survival
- Biases when using tag return data
- Recommendations
 - Eliminate non-reward tag
 - Use only one high-dollar reward tag
 - Increase value of high-dollar reward tag